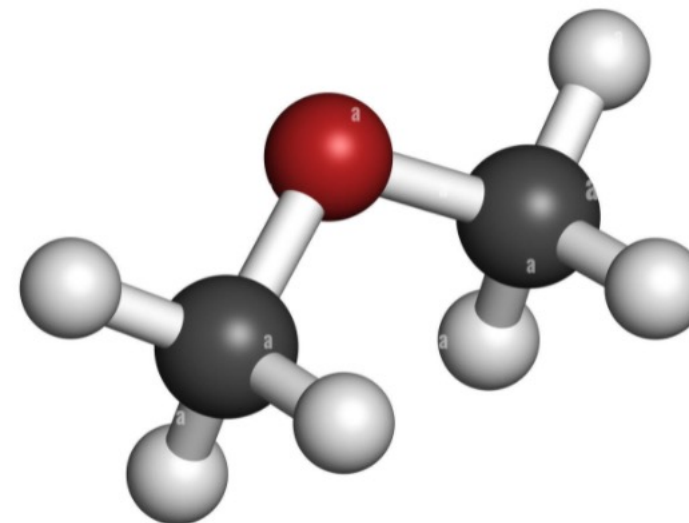
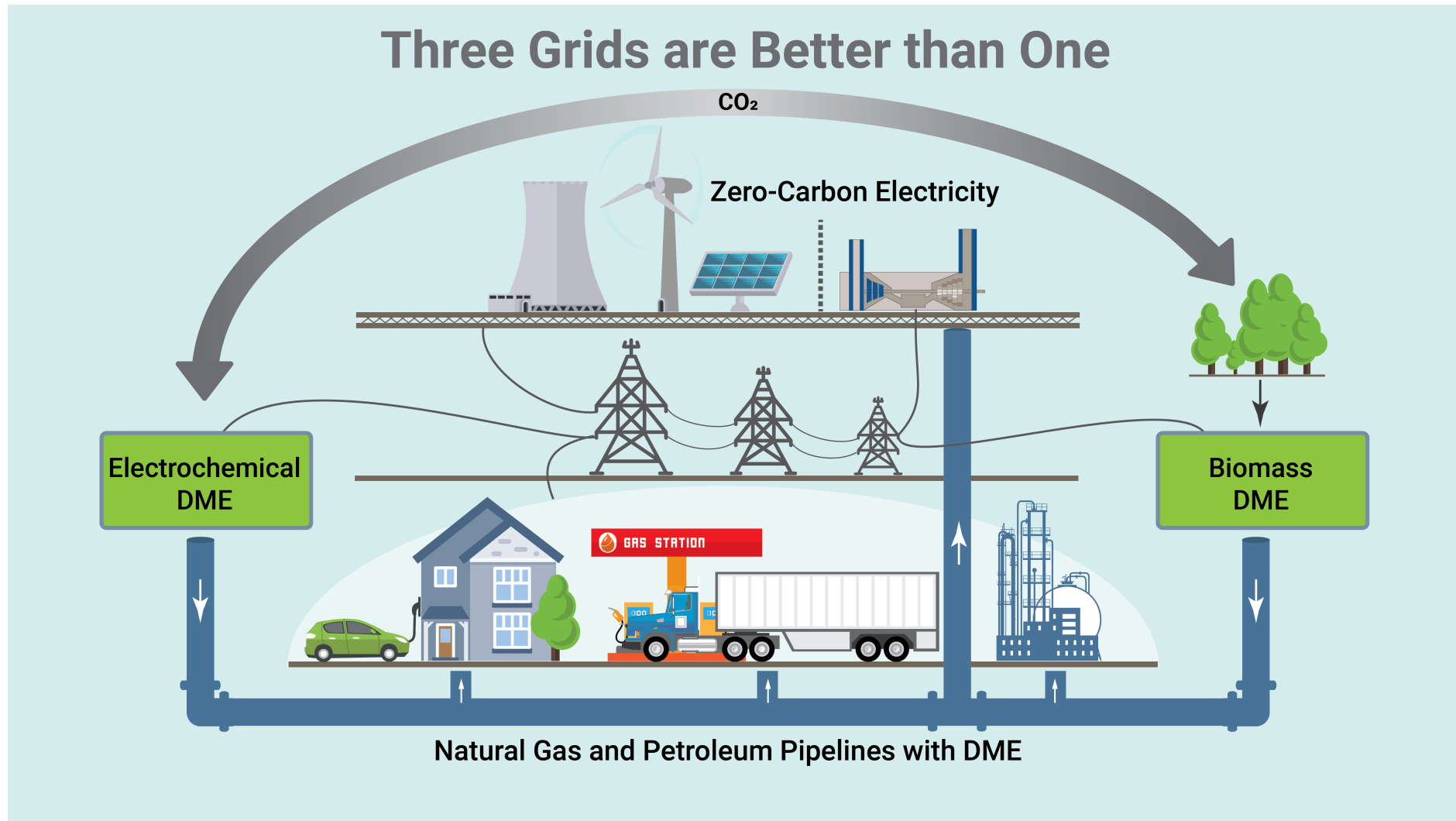


# **The Tie that Binds: Dimethyl Ether or The Most Interesting Molecule You Haven't Met (yet)**

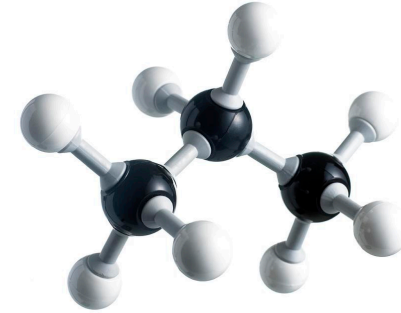
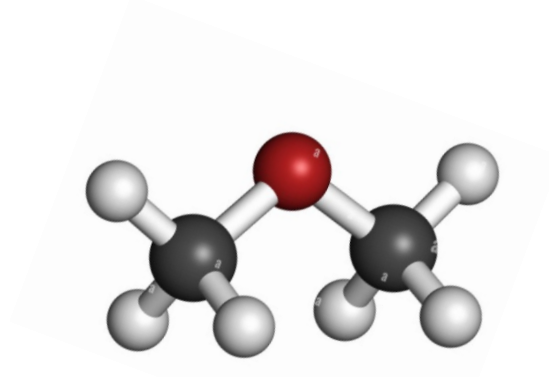
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# DME: The Tie that Binds the Electric, Gas, and Petroleum Grids



# Meet Dimethyl Ether (DME)



	DME	Propane
Chemical formula	$C_2H_6O$	$C_3H_8$
Boiling point (C)	-24	-42
Vapor pressure 25 C (kPA) (PSI)	592 86	936 135

# Compare Dimethyl Ether (DME)

	DME	Hydrogen	Methane
<b>Energy Density (MJ/m<sup>3</sup>)</b>			
Ambient conditions	59	<b>11</b>	36
Pipeline conditions (7 Mpa/1000 psi)	21,000	<b>750</b>	2400
<b>Greenhouse gas warming potential</b>	1.2 20-yr 0.3 100-yr	<b>30-60 10-yr 10-40 20-yr</b>	<b>84 20-yr 25 100-yr</b>

# Dimethyl Ether: Universal Fuel



- ▶ Replace natural gas and propane for Residential/ Commercial sectors  
8 EJ



- ▶ Gasoline precursor  
▶ (or replace with propane/DME blend)  
18 EJ



- ▶ Replace diesel  
6 EJ



- ▶ Replace petroleum for chemicals 7 EJ



- ▶ Replace natural gas for peakers 1 EJ

# Making Low-Carbon Fuels



Candidate	Low-carbon Production Options
Electricity	Wind, solar, nuclear
Hydrogen	Electricity: Power-to-X  Gray to blue from fossil sources
Renewable methane	H <sub>2</sub> + “recycled” CO <sub>2</sub>  Manure, biomass, waste
Dimethyl Ether (DME)	All of the above

# How Much Will Green Cost You?

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**Production cost**  
**+ *Delivery cost (>50% today)***  
**+ End-use hardware cost**  
**Your total cost**

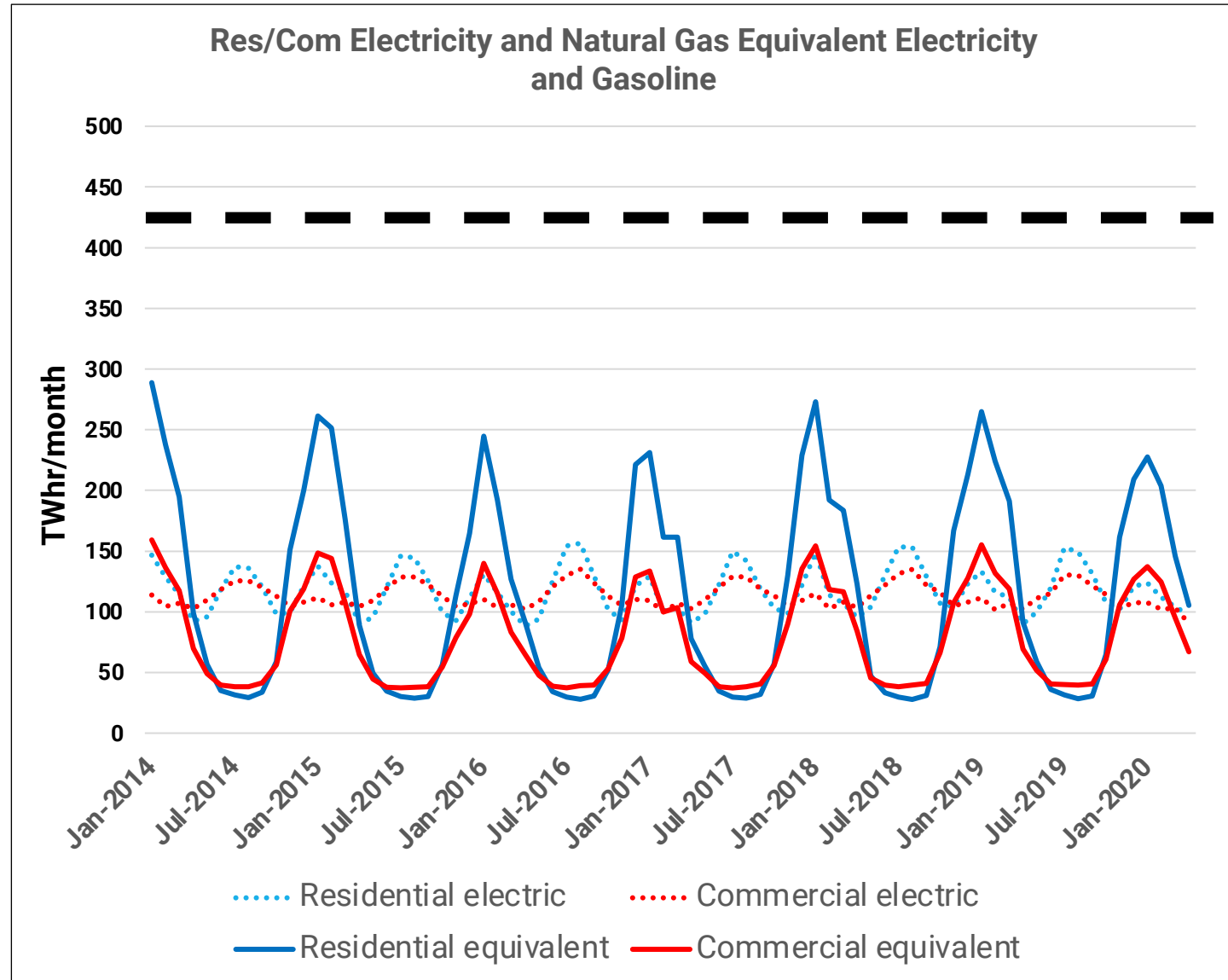


# Delivery Deep Dive

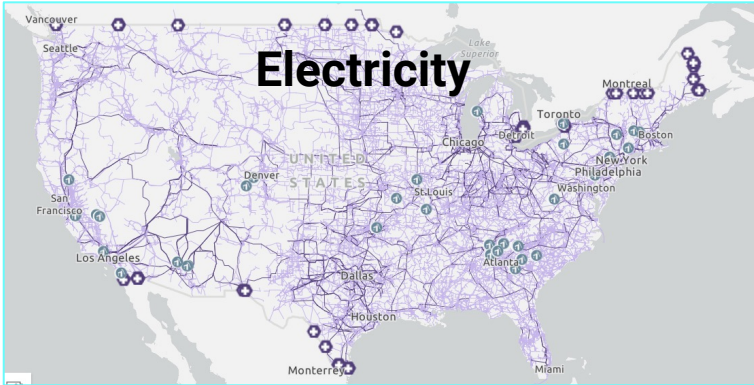
Gasoline:  
440 TWhr steady demand

Residential/Commercial  
Natural Gas:  
400 TWhr winter peak

Residential/Commercial  
Electricity:  
275 TWhr summer peak  
200 TWhr winter peak



# Three Energy Grids



- ▶ Similarities
  - ~200,000 miles interstate transmission
  - Millions of miles of smaller wires or pipes

- ▶ Differences

- CAPEX

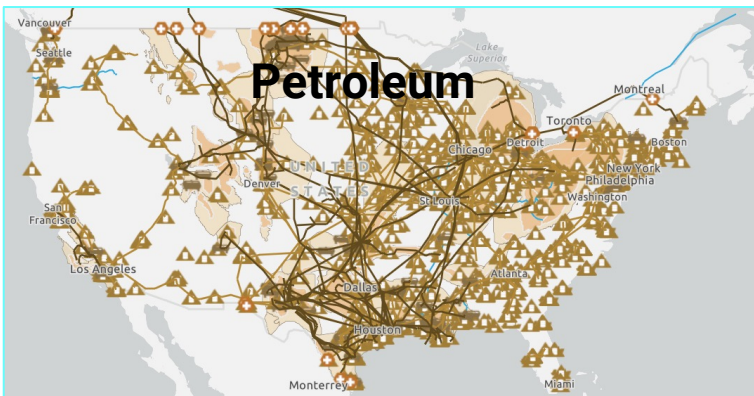
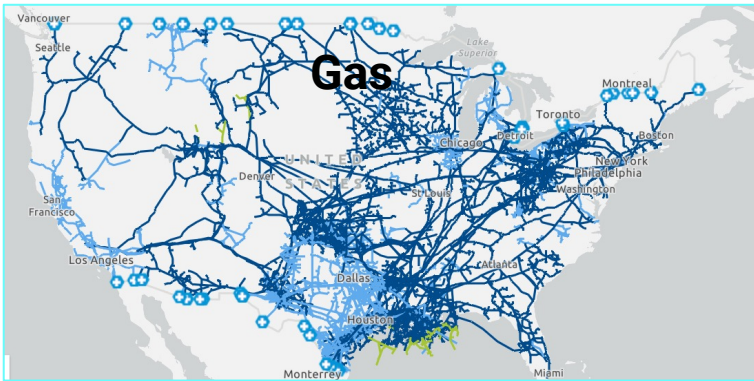
- Electric grid CAPEX 4X higher than gas grid per MW delivered
    - Most vulnerable grid for natural disasters

- Storage

- Electric: Minimal capacity today; aspire to \$100/kW-hr
    - Petroleum: 1000 terminals, 7 EJ storage, <\$0.5/kW-hr

- Latent Capacity

- Gas grid has enormous latent capacity; under-utilized 99.5% of time, DME increases capacity 60%



# What's Your Bottom Line?



Candidate	Make (\$/MW-hr)	Deliver (\$/MW-hr)	Use (8 EJ, heat, 24 EJ vehicles)
Electricity	\$40 including storage \$30 future?	\$100-250+ Expand electric grid >2X for heat + 2X for vehicles	Replace 75 MM water heaters/ furnaces; 270 MM vehicles
Hydrogen	\$120-200 today \$35 H2Shot	\$100-200+ Expand gas grid 3X for heat +3X for vehicles, modify pipelines and compressor stations	Replace 75 MM water heaters/ furnaces; 270 MM vehicles
Renewable methane	\$25-140 today \$25-100 future	\$35 No gas grid investment	Impact limited to heat; keep your furnace and water heat.
Dimethyl Ether (DME)	\$60-400 today Future??	\$35 Repurpose gas and petroleum grids with minimal investment	Keep your furnace, water heater, and vehicles

# Final Thoughts

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- ▶ Keep options open for energy carriers
  - DME is one of possibly many energy carriers that could play a role
  - Silver buckshot, not silver bullets
  - Markets can sort out the best and highest uses for low-carbon energy options
- ▶ System-level analysis: production, distribution, use
  - Environmental impacts
  - Cost implications
  - Repurposing existing infrastructure is also green

# DME: The Tie that Binds the Electric, Gas, and Petroleum Grids

